Scalable Performance Oscilloscopes

DPO70000SX Series Datasheet

DPO70000SX provides ultra-high bandwidth real time signal acquisition and analysis up to 70 GHz analog bandwidth. The patented Asynchronous Time Interleaving (ATI) architecture provides the lowest noise and highest fidelity for real time signal acquisition.

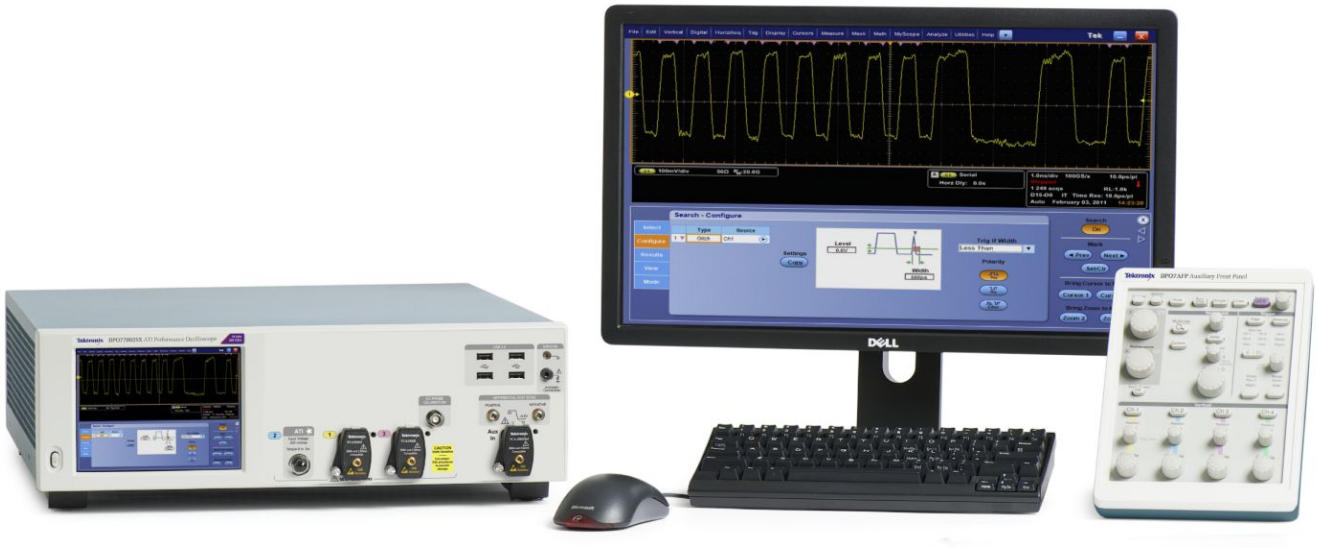
- Superior signal fidelity and excellent signal-to-noise ratio
- Stable and precise multi-channel timing for most accurate analysis
- Compact instrument package with flexibility for future expansion and simple reconfiguration

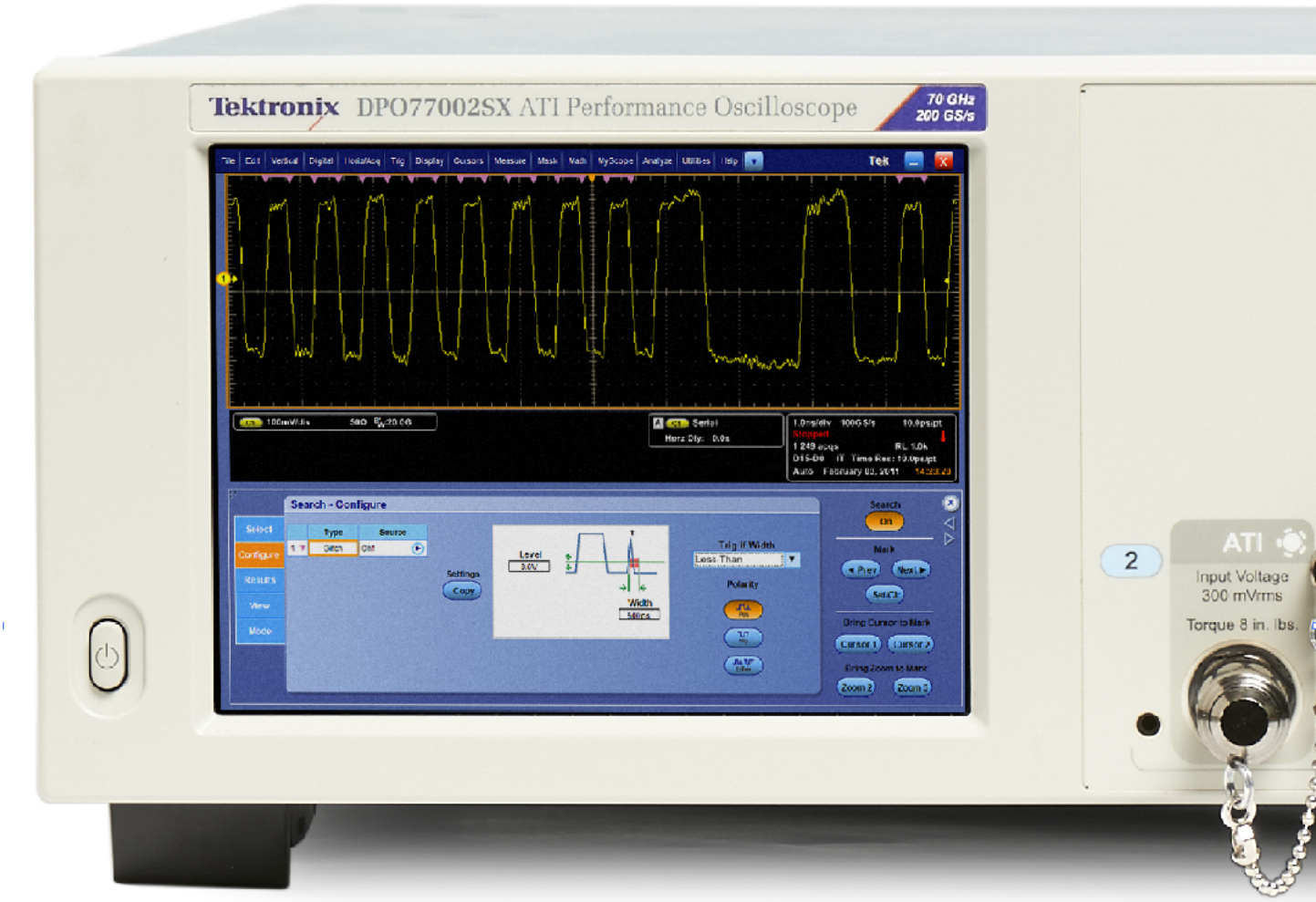
Introduction

DPO70000SX-series oscilloscopes provide the most accurate real time performance for ultra-bandwidth applications.

- Low noise, 70 GHz real time signal capture using patented ATI architecture
- Compact 5 ¼" (3U) instrument package for the most versatile multi-channel systems
- Precise, scalable performance using UltraSync multi-unit time synchronization bus
- Highest trigger performance with >25 GHz Edge trigger bandwidth, unique new Envelope trigger

Low-noise, high fidelity signal acquisition is critical in ultra-bandwidth applications such as long-haul coherent optical, 400G datacomm and wideband RF. The flagship DPO77002SX model uses ATI (Asynchronous Time Interleaving) architecture to achieve 70 GHz and 200 GS/s (5 ps/Sample) real time acquisition performance. This patented, symmetric architecture elegantly creates an inherent noise advantage over legacy bandwidth interleaving methods. The DPO70000SX provides the lowest noise, highest fidelity and maximum performance for complex optical modulation analysis, jitter and noise analysis of high speed serial signaling and frequency, phase and modulation analysis of wideband RF signals.





DPO70000SX ATI Performance Oscilloscopes

- 70 GHz, 59 GHz, or 50 GHz analog bandwidth
- Low-noise ATI architecture
- 200 GS/s, 5 ps/Sample real-time sample rate

DPO70000SX Digital Phosphor Oscilloscopes

- 33 GHz or 23 GHz analog bandwidth
- 100 GS/s, 10 ps/Sample real-time sample rate

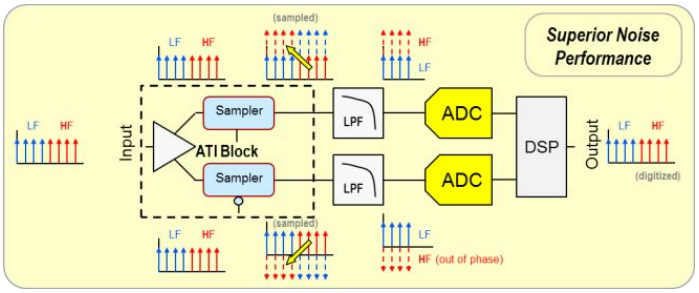
Applications

- Coherent optical modulation analysis
- Research and defense data acquisition and analysis
- Datacom analysis

ATI architecture delivers lowest noise

Current real time scope solutions for digitizing ultra-high bandwidth signals distribute signal energy to two digitizing paths then use DSP to reconstruct the input signal. Unlike legacy schemes, Tektronix' unique ATI architecture provides a symmetric technique that delivers all signal energy to both digitizing paths resulting in an inherent noise advantage.

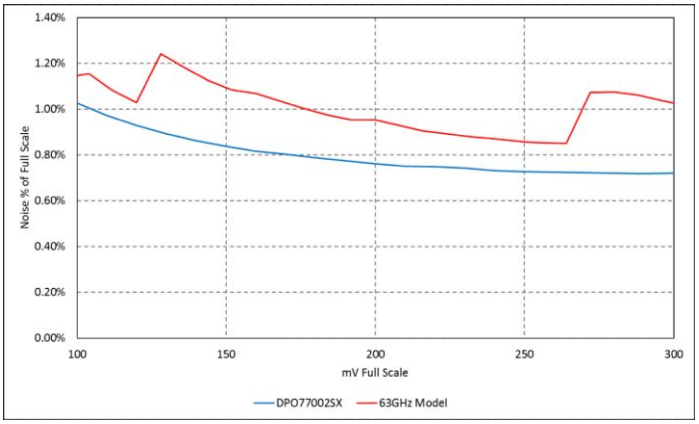
The diagram shows how an input signal enters the ATI ASIC where it is sampled and alternately delivered to each digitizing subsystem. The sample clock runs at 75 GHz and effectively folds the spectrum of the input signal about 37.5 GHz prior to digitizing. Each digitizing path operates at 100 GS/s and the folded spectrum is band limited to <40 GHz to meet Nyquist criteria. The alternating phase of the sampler has the effect of inverting signal phase 180° in one digitizing path, which provides significant benefit in reconstructing the final digitized signal.



With two copies of the entire signal energy digitized, the signal spectra are "unfolded" using a DSP equivalent of the sampling process and combined to reproduce the input signal. Because two copies of the signal are being combined the process effectively averages them together, reducing random noise. Phase-inversion introduced by the sampling process causes intermediate frequency components to directly cancel one another, simplifying reconstruction and calibration.

Thus, ATI architecture provides an inherent SNR advantage over legacy digital-bandwidth interleaving techniques. These techniques immediately split an input signal into upper and lower bands of frequencies. This divides the power and the upper frequency band must be mixed down prior to digitizing while the lower band is directly digitized. This asymmetric approach can make signal reconstruction and calibration more difficult and lead to errors in pass-band frequency or phase response. The division of power removes the opportunity to reduce signal noise. ATI alleviates these issues by using a unique symmetric architecture.

A comparison of baseline noise between the Tektronix DPO77002SX and another vendor's 63 GHz model, with both instruments set to 60 GHz bandwidth, demonstrates the effectiveness of ATI at providing the lowest noise acquisition.

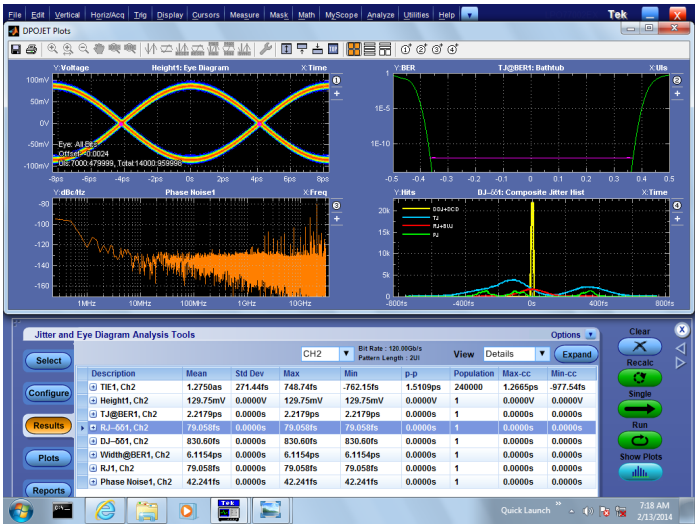


DPO77002SX vs. other vendor's 63 GHz model: Baseline noise % of FS vs. mV_{FS} setting, with trace centered, at 60 GHz BW, maximum sample rate setting (200 GS/s or 160 GS/s)

JNF performance

An all-new master sample clock design which provides the remarkably low sample clock jitter of $65fs_{RMS}$, combined with the very low noise performance achieved with ATI, allows the DPO77002SX to reach new levels of jitter noise floor performance. The JNF at 300 mV_{FS} is a mere 123 fs_{RMS}, which even rivals lower bandwidth instruments.

The figure shows jitter analysis of 60 GHz sine wave applied to the ATI input. The result shows a clean eye with random jitter RJ <80 fs_{RMS}.

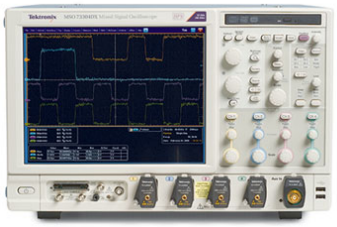


Compact ultra-performance oscilloscope

DPO70000SX-series models establish a unique compact oscilloscope package that enables unprecedented workspace efficiency and mounting versatility. The SX-series provides a differentiated approach to ultra-bandwidth real time acquisition that aligns with user trends toward large external monitors, higher degrees of automation and increased separation of data collection and data analysis workspaces.

Stand-alone DPO70000SX compact models provide functionality equivalent to their bench counterparts (DPO70000DX) at half the height through addition of external display, keyboard and mouse. SX-series models can host Advanced Analysis software and be automated using internal or external control just as their bench counterparts.

The DPO77002SX 70 GHz ATI Performance Oscilloscope provides one channel at 70 GHz, 200 GS/s acquisition performance or two channels at 33 GHz, 100 GS/s acquisition. The instrument includes a 70 GHz, 1.85 mm low-noise ATI input channel as well as general purpose TekConnect 2.92 mm inputs for versatile probing and signal conditioning options to 33 GHz.



The DPO73304SX model provides two channels at 33 GHz, 100 GS/s acquisition or four channels at 23 GHz, 50 GS/s real time acquisition performance. This model provides acquisition performance similar to the DPO73304DX bench model, but in the new compact instrument form-factor.

All models in the DPO70000SX-series achieve the highest level of trigger performance available in real time oscilloscopes, >25 GHz edge trigger performance and <40 ps glitch trigger performance. An innovative new Window trigger type enables triggering on the envelope of RF signal bursts with time-qualification to discriminate envelope width. Industry-leading pulse-width timer performance enables the most precise discrimination of specific bit-widths in high speed serial data streams and detection of "runt" pulses in the midst of pseudo-random signaling. The DPO70000SX-series Auxiliary Trigger input provides low-jitter edge triggering and uses TekConnect accessories for a wide variety of signal conditioning solutions.

Optimal usability

Less than half the height of bench models

DPO70000SX-series instruments are contained in a 5 ¼" (3U) package that optimizes space usage and enables the most versatile range of mounting configurations. Two DPO70000SX instruments stack in less height than similar-class bench instruments, yet achieve higher measurement performance.

Complete standalone oscilloscope

Though compact, SX-series models provide full standalone oscilloscope functionality and performance. They can directly host Tektronix' Advanced Analysis applications for tasks such as jitter, noise, optical modulation or spectral analysis and do not require a separate processor or control unit.

2 x 70 GHz, 4 x 33 GHz configuration with monitor and auxiliary front panel

Familiar scope controls where you want them

The DPO7AFP Auxiliary Front Panel is a valuable usability accessory that compliments the compact instrument package by enabling users to operate with familiar controls without requiring access to the front of an instrument.

The Auxiliary Front Panel provides the same control set embedded in DPO/DSA/MSO/7000/70000 bench instruments as a separately packaged USB peripheral. This accessory enhances usability even when the instrument front panel may be obscured due to mounting location.

Remote desktop operation

As with current bench-model DPO /MSO70000-series instruments, DPO70000SX models can be operated remotely over a network using Windows® Remote Desktop. Use the Windows Remote Desktop utility to access your oscilloscope from across the lab or across the globe.

Precision synchronization for multi-unit systems

DPO70000SX-series instruments include the Tektronix UltraSync multi-unit time synchronization bus. UltraSync is used to synchronize sample clock, trigger and run-stop control across multiple units with performance equivalent to that found in monolithic scopes. UltraSync cables are available in 1 meter and 2 meter length to maximize configuration and layout versatility while preserving timing integrity of a multi-unit system.

- 12.5 GHz Sample Clock Reference
- Coordinated Trigger
- High speed data path

The UltraSync bus consists of three elements, each providing an important element of precise multi-unit operation:

- UltraSync includes a 12.5 GHz Sample Clock Reference signal sourced by the Master and used by each Extension to synchronize sample placement in the digitizing process.

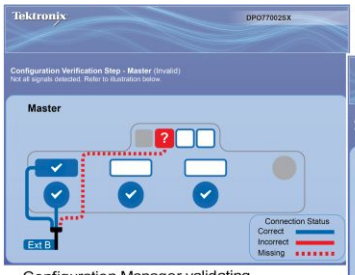
UltraSync connection on instrument with Master role

UltraSync connection on instrument with Extension role

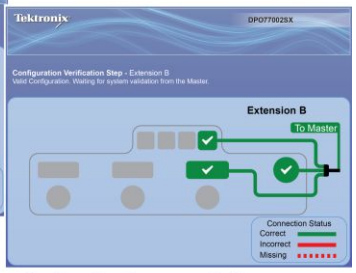
- The Trigger bus provides Run-Stop control for all members of a multi-unit configuration and enables the trigger source to be from a Master or Extension unit.
- Control & data transfer from Extension units to the Master are managed with a PCIe, Gen 2, x4 link capable of 2 GB/s data transfer rate.

When operating in a multi-unit instrument configuration, one DPO70000SX has the role of Master, controlling one or more units operating in Extension mode. Any DPO70000SX model can operate as a standalone oscilloscope or serve as Master or Extension in a multi-unit configuration. Roles are determined by UltraSync cabling and no additional elements are needed. This allows users to decouple multi-unit configurations at any time and operate instruments in a standalone fashion without requiring a control unit or other accessories. Or, standalone units can be easily combined by simply adding UltraSync cables between Master and Extension.

During startup of a multi-unit configuration a Configuration Manager application validates Master-Extension cabling and provides graphical feedback if elements are missing or misconfigured. Following validation, the system presents the TekScope user interface where waveforms from Master and Extension units are gathered for display and analysis using built-in features and Advanced Analysis applications.



Configuration Manager validating Master connections



Configuration Manager validating Extension connections

Scalable performance and versatile configurations

DPO70000SX multi-unit modes enable a variety of extended performance and increased channel-count configurations. Master-Extension configurations provide additional input channels synchronized to the same degree of precision as internal channels and controlled from a single user interface as an interactive instrument or programming interface in automated applications.

This scalable approach to performance allows users to purchase performance suitable for today's requirements, such as four channels of 33 GHz, 100 GS/s acquisition while also having two channels with 70 GHz, 200 GS/s performance suitable for next-generation designs. Subsequently, two additional units can be added for a total of four channels at 70 GHz, 200 GS/s. Units in this four-unit configuration can be separately deployed as pairs or standalone units at any time to meet other test demands.

The DPO77002SX also offers a unique value proposition in single-channel 70 GHz, 200 GS/s applications such as RF analysis or pulsed laser studies. In these cases a user can purchase a single unit for 70 GHz channel performance along with two channels at 33 GHz. Additional units can be purchased at a later time and combined using UltraSync if higher channel count is needed.

The following multi-unit configurations are supported:

2 DPO77002SX: 2 Ch @ 70 GHz, 200 GS/s or 4 Ch @ 33 GHz, 100 GS/s

4 DPO77002SX: 4 Ch @ 70 GHz, 200 GS/s or 4 Ch [1] @ 33 GHz, 100 GS/s

2 DPO75902SX: 2 Ch @ 59 GHz, 200 GS/s or 4 Ch @ 33 GHz, 100 GS/s

4 DPO75902SX: 4 Ch @ 59 GHz, 200 GS/s or 4 Ch [1] @ 33 GHz, 100 GS/s

2 DPO75002SX: 2 Ch @ 50 GHz, 200 GS/s or 4 Ch @ 33 GHz, 100 GS/s

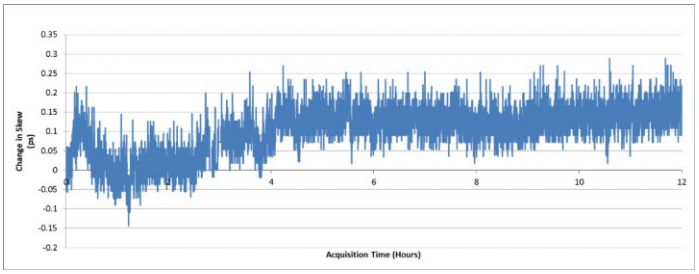
4 DPO75002SX: 4 Ch @ 50 GHz, 200 GS/s or 4 Ch [1] @ 33 GHz, 100 GS/s

2 DPO73304SX: 4 Ch @ 33 GHz, 100 GS/s or 4 Ch [1] @ 23 GHz, 50 GS/s

2 DPO72304SX: 4 Ch @ 23 GHz, 100 GS/s or 4 Ch [1] @ 23 GHz, 50 GS/s

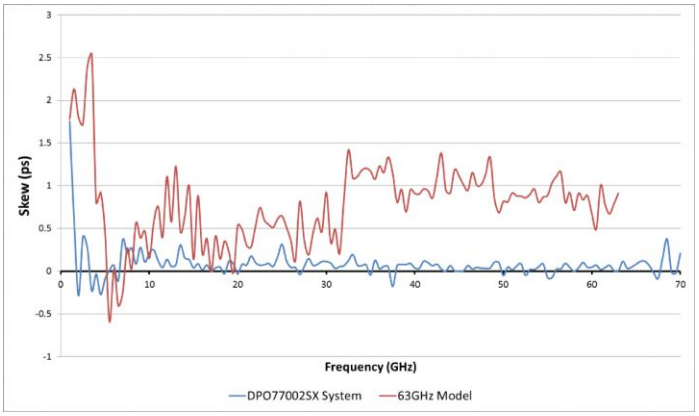
Skew Stability

UltraSync provides outstanding integration and time alignment between units in a multi-unit stack. Once channels have been deskewed in a multi-unit stack, skew is very stable over time and temperature. The specification for skew stability is ≤250 fs_{RMS}. The following DPO77002SX skew measurement plot shows that even when including the startup temperature stabilization period (approximately 1 hour), the pk-pk variation is about 400 fs, and is about 350 fs pk-pk after the 1-hour warm-up period. This plot also shows exceptional consistency over this 12-hour data collection.



Change in channel-to-channel skew of DPO77002SX system over time.

Another important aspect of skew is how the phase relationship between two channels varies with changing frequency (group delay effects). The following plot compares the performance of a DPS77004SX 70 GHz two-unit system against the performance of another vendor's 63 GHz frequency-interleaved channels. What you see here is that the UltraSync two-channel skew performance dramatically surpasses the performance of a another vendor's single 63 GHz model containing two channels.



Channel skew vs. Frequency comparison between DPO77002SX system and other vendor's 63 GHz model.

Short signal path

Minimizing input signal path length is especially important when working at 70 GHz ultra-high bandwidth. The compact nature of DPO70000SX creates more versatile mounting options when co-locating instrument and device under test (DUT). Options such as the Auxiliary Front Panel and Remote Desktop connection allow further flexibility by eliminating the need for direct access to the instrument front panel once connected. As a result, the SX-series enables the broadest range of options when dealing with a variety of DUT configurations as compared to classic bench instruments.

Input signal path length may be minimized in multi-unit configurations by inverting one unit of a pair. The low, central location of the 70 GHz ATI input provides very small input connector spacing when operating units in this configuration.

Instruments can also be arranged at various angles to suit DUT layout, such as at right angles for card-and-backplane situation or face-to-face around a small DUT. Layouts such as this create the shortest input signal path and maximize SNR. In addition, effects of signal path elements such as cables and adapters can be characterized and removed using the Serial Data Link Analysis application to obtain the best analysis results and insight.

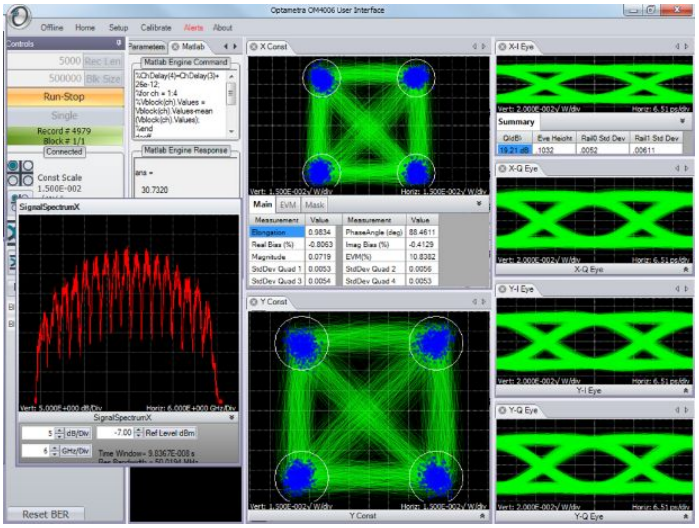
1 Maximum of 4 channels displayed on-screen. Access to additional channels data available through program interface.

Applications

Coherent optical modulation analysis

Tektronix DPO70000SX oscilloscopes are ideal for modulation format analysis of 400 Gb/s and Terabit-based coherent optical networking systems. The unique architecture enables scalability to grow instrument performance by adding channels or more bandwidth; to test 100 G cost effectively now and expand into 400 G or 1 Terabit later. The DPO70000SX low profile reduces concerns of signal loss in system connectivity on your coherent measurements by placing the Optical Receiver as close as possible to the instrument's input channel.

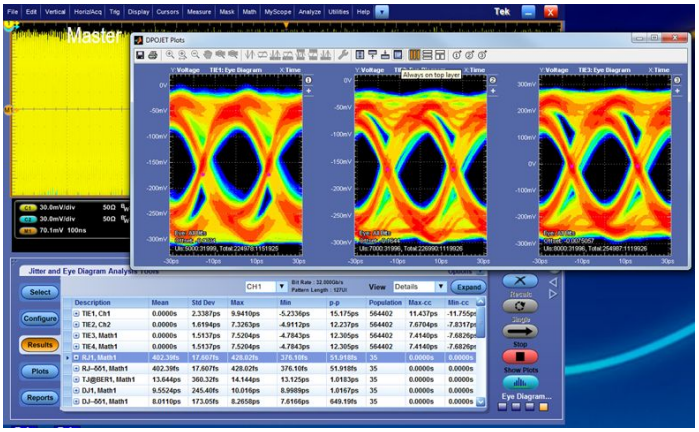
More accurate modulation analysis starts with a lower Error Vector Magnitude (EVM) floor in the instrument. The DPO70000SX Oscilloscope utilizes ATI technology to provide the industry's lowest noise floor supporting these measurements. In addition, the system is achieving four channels of full 70 GHz Bandwidth at 200 GS/s per channel, providing a very rich analysis environment. When used in conjunction with the OM4524 Optical Modulation Receiver, optical system research engineers can customize their DSP analysis and visualization for non-standard modulation techniques using easy customer-specific implementations with extensive customizable analysis SW that leverages Matlab™.



- 70 GHz Bandwidth on 4 Channels for 1 Terabit/s systems
- Industry-best lowest noise for low EVM
- 200 GS/s sampling on 4 channels for phase tracking
- Compact form factor with scalability for channel & bandwidth
- Customizable DSP for unique analysis needs

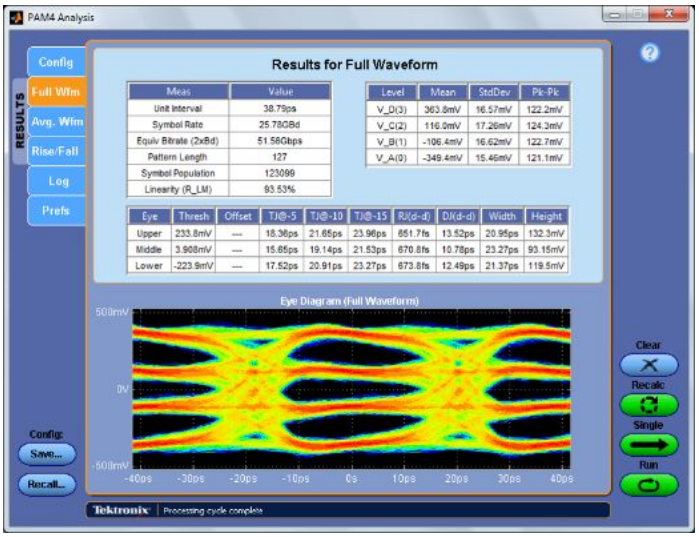
PAM4 and NRZ datacom measurements

As datacom networks increase their throughput, the DPO70000SX is ready to perform standards validation for many of today's 25/28 G industry standards (see chart below). With 50 GHz and 70 GHz models featuring the low-noise ATI architecture; the DPO70000SX, combined with DPOJET Jitter & Noise Analysis and the SDLA Serial Data Link Analysis tools, can perform accurate de-embedding and eye diagram evaluation on many of these key standards.



Datacom Standards	Recommended Bandwidth	Tektronix Scope Model
Ethernet		
-10GBASE KRn	25GHz	DPO72504DX
- 100GBASE KR-4, CR-4	50GHz	DPS75004SX
- 25 Gb Phy KR, CR for 100G	40GHz	DPS75004SX
Fibre Channel		
-16Gb	30GHz	DPS75004SX
-32Gb	45GHz	DPS75004SX
Infiniband		
-EDR 25Gb	40GHz	DPS75004SX
OIF-CEI 3.0		
- CEI-25G	40GHz	DPS75004SX
OIF-CEI 3.1		
- CEI-56G (PAM4)	40GHz	DPS75004SX
- CEI-56G (NRZ)	40GHz	DPS75004SX

With 400 G networking, new serial data transmission speeds will reach 56 Gb/s per channel, making NRZ signaling techniques ineffective, leading to bandwidth efficient PAM4 (4 level pulse amplitude modulation). Accurate PAM4 validation is best conducted using the DPO70000SX Series with its industry-leading low noise ATI technology to achieve good effective bits performance on measurement results. For analysis of PAM4, the DPO70000SX Option PAM4 provides built-in software clock recovery, multi-level eye diagram plots and unique report tables for effective measurements as show below.



- Built-in clock recovery for PAM4 and NRZ-based signals up to 140 Gb/s
- Fine timing resolution with up to 200 GS/s sampling on each differential channel
- Debug edge timing using 25 GHz hardware trigger system

RF

With its low noise and flat frequency response to 70 GHz, the DPO70000SX opens opportunities for measurement and analysis of wideband RF signals.

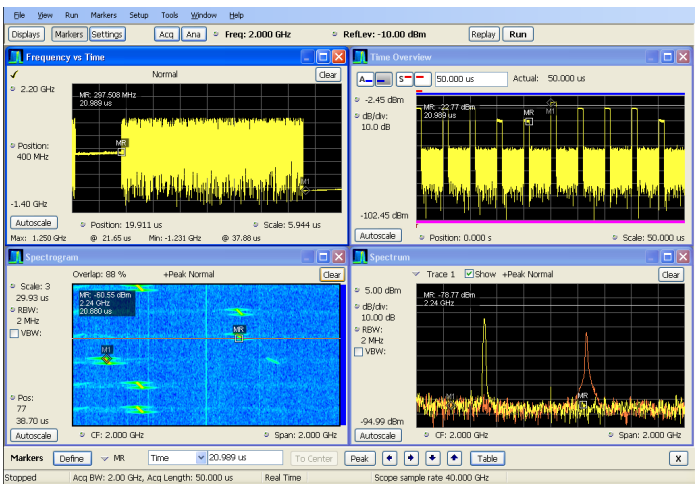
SignalVu® vector signal analysis – When vector signal analysis of RF or baseband signals are needed, the optional SignalVu application enables measurements in multiple domains (frequency, time, phase, modulation) simultaneously. SignalVu measurements are fully correlated with the scope's time domain acquisition and triggering. Time domain events, such as commands to an RF subsystem, can be used as trigger events, while the subsystem's RF signal can be seen in the frequency domain.

In addition to spectrum analysis, spectrograms display both frequency and amplitude changes over time. Time-correlated measurements can be made across the frequency, phase, amplitude, and modulation domains. This is ideal for signal analysis that includes frequency hopping, pulse characteristics, modulation switching, settling time, bandwidth changes, and intermittent signals.

SignalVu can process RF, I and Q, and differential I and Q signals from any oscilloscope inputs. Math functions applied by the oscilloscope are also used by SignalVu allowing users to apply custom filtering prior to vector signal analysis.

The Microsoft Windows environment makes the use of this multi-domain analysis even easier with an unlimited number of analysis windows, all time-correlated, to provide deeper insight into signal behavior. With a user interface that adapts to your preferences (keyboard, front panel, touch screen, and mouse), SignalVu is easy to apply for both first-time users and experienced hands.

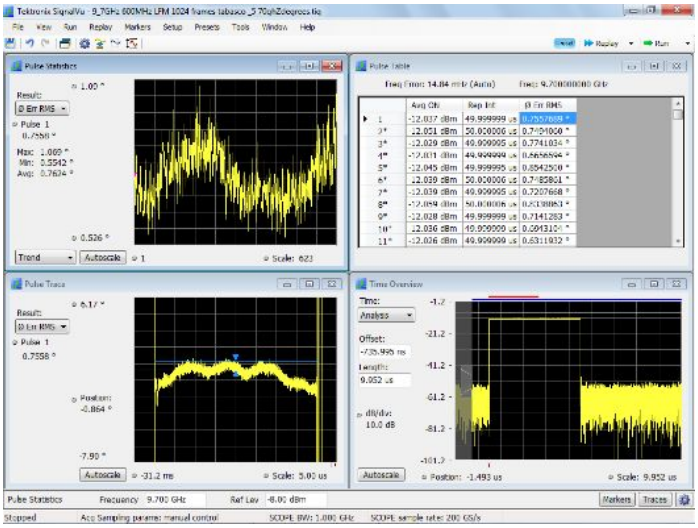
Time-correlated, multi-domain view provides a new level of insight into design or operational problems not possible with conventional analysis solutions. Here, the hop patterns of a narrowband signal can be observed using Spectrogram (lower left) and its hop characteristics can be precisely measured with Frequency vs Time display (upper left). The time and frequency responses can be observed in the two right-hand views as the signal hops from one frequency to the next.



Radar and high frequency-based analysis – The low-noise, high bandwidth DPO70000SX Series Oscilloscope is ideal for high frequency FFT-based measurement analysis. When combined with the powerful SignalVu software analysis option, the DPO70000SX instrument provides FFT (fast fourier transform) measurement capability up to 70 GHz. With its scalable instrument architecture, RF engineers can obtain a single channel unit for RF input-only measurements and grow to multi-unit configurations for comprehensive RF system validation.

Examples of high-frequency RF measurements with the DPO70000SX include:

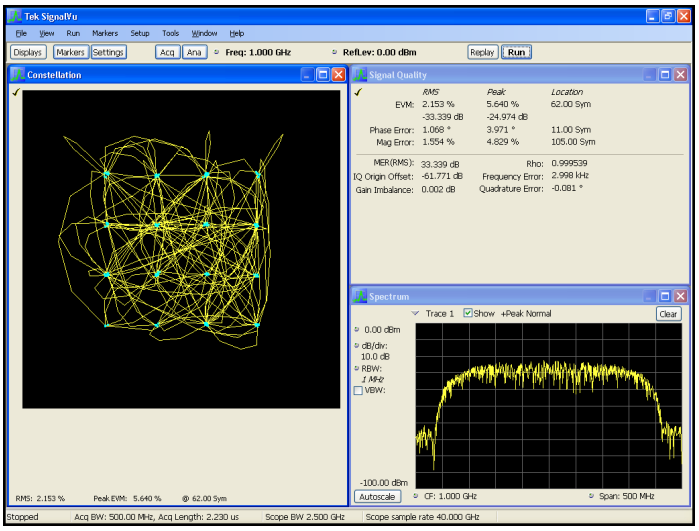
- Chirp Linearity measurements on Radar signals (see below figure)
- Wireless measurements on IEEE802.11ad e.g. (60.48 GHz carrier frequency)
- Monitor & debug satellite communications over K-Band (20-40 GHz)



Once low-noise waveform data is captured by the 70 GHz DPO70000SX, SignalVu can be used to demodulate the signal, and display a constellation diagram and Error Vector Magnitude (EVM) measurement and other needed measurements. SignalVu also provides detailed analysis in multiple domains as additional options, such as pulse analysis and settling time for Radar systems work, digital modulation analysis and flexible OFDM analysis for emerging modulation standards, as well as AM/FM/PM modulation and audio measurements for lower bandwidth requirements.

- Industry low-noise enables low EVM floor
- 70 GHz provides wide dynamic range and accurate chirp linearity
- Integrated FFT & Phase Plot creation provides fast, accurate frequency domain measurements

Options tailored for your wideband applications – SignalVu vector signal analysis software offers options to meet your specific application, whether it be wideband radar characterization, broadband satellite, or spectrum management. SignalVu Essentials (Opt. SVE) provides the fundamental capability for all measurements and is required for pulse analysis (Opt. SVP), settling time (Opt. SVT), digital modulation analysis (Opt. SVM), flexible OFDM analysis (Opt. SVO), and AM/FM/PM Modulation and Audio Measurements (Opt. SVA). Wideband satellite and point-to-point microwave links can be directly observed with SignalVu analysis software.

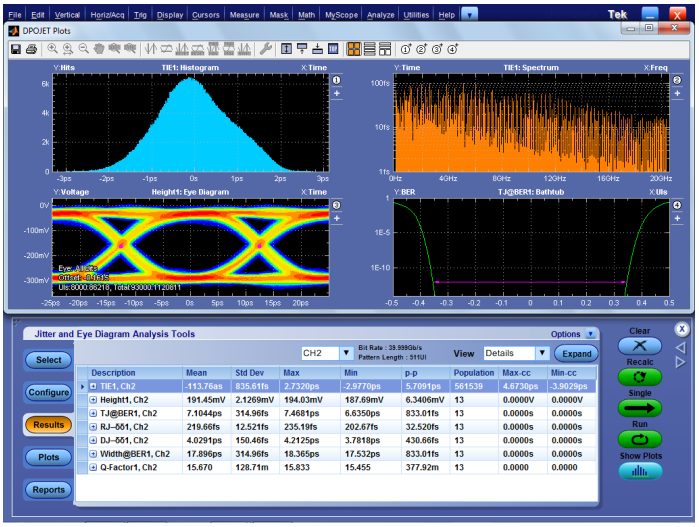


General Purpose Digital Modulation Analysis (Opt. SVM) used to demodulating a 16QAM backhaul link running at 312.5 MS/s.

Advanced analysis

DPOJET Comprehensive Jitter and Noise Analysis

DPOJET provides engineers the highest measurement sensitivity and accuracy available in real-time instruments. With comprehensive jitter and eye-diagram analysis and decomposition algorithms DPOJET simplifies discovering signal integrity concerns and jitter and their related sources in today's high-speed serial, digital, and communication system designs.



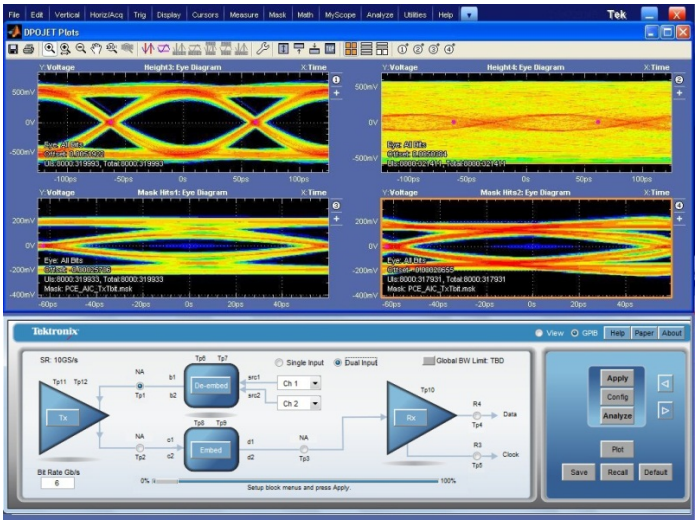
DPOJET Jitter and Eye Diagram Analysis - Simplify identifying signal integrity issues, jitter, and their related sources.

Noise analysis with DPOJET (Opt. DJAN)

Jitter essentials, advanced analysis and custom extensions – DPOJET Essentials is standard on the DPO70000SX Series with the DPOJET advanced version available as an option. Application-specific measurement packages are also available that extend DPOJET and perform the extensive set of tests required by industry standard groups.

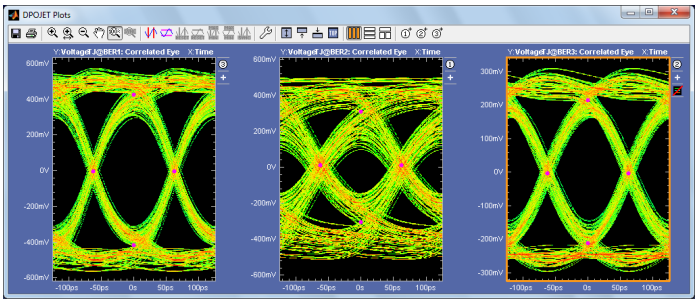
SDLA signal path de-embed and custom filters

Acceleration of signaling speeds and shrinking geometries create several challenges for next generation multi-gigabit designs and test methodologies. Designs are evolving to address these challenges with advanced equalization techniques at the transmitter and receiver. Smaller form factors make signal access more difficult, resulting in non-ideal probing points. This can lead to loss and reflections on the acquired signal due to impedance discontinuities that are not present at the ideal measurement location. The advanced techniques employed by the designs call for advanced measurement solutions. The challenge begins with the signal acquisition; capturing a signal through cables, probes and fixtures distort the signal shape. SDLA Visualizer allows you to de-embed the effects (reflections, insertion loss, and cross coupling) of the measurement circuit (cables, probes, and fixtures) from the waveform while taking into account the transmitter output and receiver input impedance. De-embedding these effects improves the accuracy of measurements and can make the difference between passing or failing a test.



Signal path equalization – Using the optional Serial Data Link Analysis Visualizer (SDLA64) application, you can gain further insight into serial data links with the capability to emulate the serial data channel from its S-parameters, remove reflections, cross- coupling, and loss caused by fixtures, cables, or probes, and open closed eyes caused by channel effects using receiver equalization techniques, such as CTLE, DFE, FFE. IBIS-AMI models for silicon-specific receiver equalization can used to observe on-chip behavior.

The eye diagrams below illustrate the correlated eye of a signal before a channel, after a channel, and after equalization. Eye closure due to channel effects have effectively been removed using SDLA and in this case the eye widths are within ~3 ps as shown in the eye diagram on the left and right hand sides.



Custom filters – Create your own filters or use the filters provided standard with the DPO70000SX Series to enhance your ability to isolate or remove a component of your signal (noise or specific harmonics of the signal). These customizable FIR filters can be used to implement signal-processing techniques, such as removing signal pre-emphasis or minimizing the effects of fixtures and cables connected to the device under test.

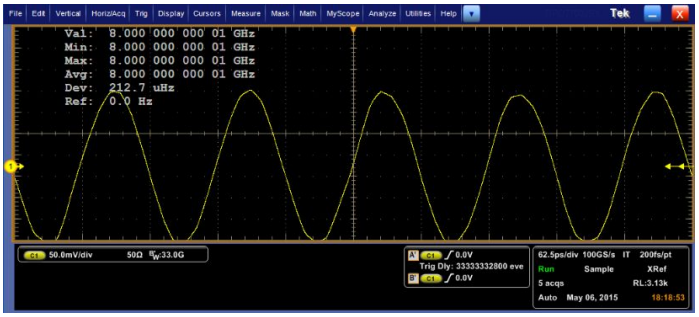
Built-in analysis system – DPO70000SX includes a wide variety of built-in features for visualizing and measuring signal behaviors. Select from 54 automatic measurements using a graphical palette that logically organizes measurements into Amplitude, Time, Histogram, and Communications categories. Gather further insight into your measurement results with statistical data such as mean, min, max, standard deviation, and population.

Define and apply math expressions to waveform data for on-screen results in terms that you can use. Access common waveform math functions with the touch of a button. Or, for advanced applications, create algebraic expressions consisting of live waveforms, reference waveforms, math functions, measurement values, scalars, and user-adjustable variables with an easy-to-use calculator-style editor.

With deep acquisition memory, margin testing can be done over many cycles and long duration trends in the data can be observed. Plus, data from the oscilloscope can be captured into Microsoft Excel using the unique Excel toolbar, and formatted into custom reports using the Word toolbar provided with the DPO70000SX Series.

Counter timer

The high resolution counter/timer is a new optional feature that is made possible by the new trigger system in the DPO70000SX series oscilloscopes. This is a precision frequency counter which provides frequency analysis up to 25 GHz, with up to 13 digits of resolution and 12 digits/second. Using the internal clock, this counter is accurate to better than 1 ppm. Higher accuracy is possible using a high precision external clock source. Because this measurement is made through the trigger system, it measures each and every cycle of the signal on a continuous basis during the trigger gate time, rather than making measurements on finite blocks of data through the normal acquisition channel.



This feature provides the ability to make highly accurate clock stability measurements. In the screen capture shown, a deviation of 212 µHz of source wander is measured on an 8 GHz precision source. In this figure, the signal generator was set to 8.00000000001 GHz, and the scope measured precisely that amount.

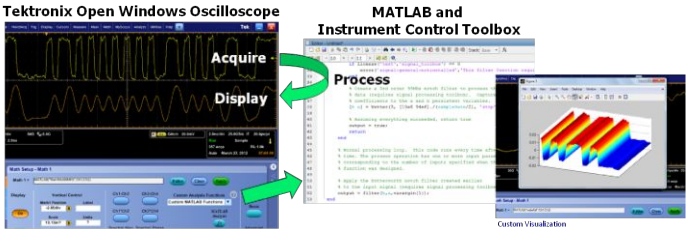
The timer allows precise measurements between trigger events with a 200 fs resolution, and can include time measurements from an A event to a B event, where A and B events can be any valid trigger mode (e.g. Glitch, Runt, Edge, etc). This feature is useful for measuring propagation delays, or analyzing anomaly occurrence rates.

Three important distinctions between this counter/timer and conventional counter/timers are:

- > 25 GHz analog bandwidth
- Wide selection of high bandwidth scope probes available for the highest signal fidelity connection to the DUT
- Ability to view the waveform on-screen to insure the counter/timer is seeing a valid waveform, and that trigger levels are set appropriately for the waveform

Custom math expressions with MATLAB

Tektronix custom math expressions with MATLAB enable users to create MATLAB scripts that process live waveform data and return results into scope math traces. Extensions can also use MATLAB features to create specialized analysis and visualizations.



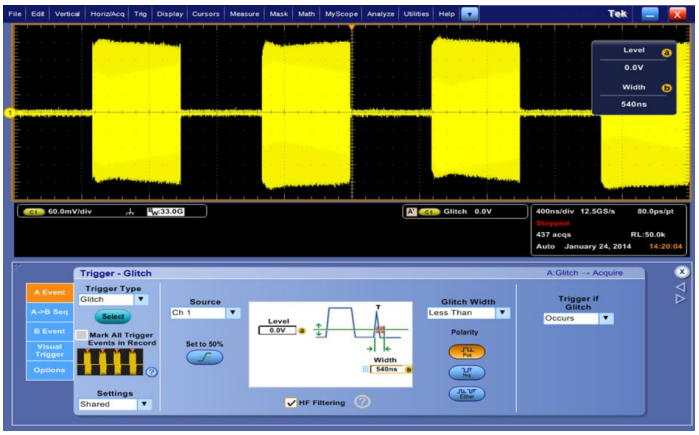
Pinpoint® trigger

Whether you're trying to find a problem signal or need to isolate a section of a complex signal for further analysis, Tektronix Pinpoint® triggering provides the solution. Pinpoint® triggering allows selection of virtually all trigger types on both A and B trigger events delivering the full suite of advanced trigger types for finding sequential trigger events. Pinpoint® triggers provide trigger reset capabilities that begin the trigger sequence again after a specified time, state, or transition so that even events in the most complex signals can be captured.

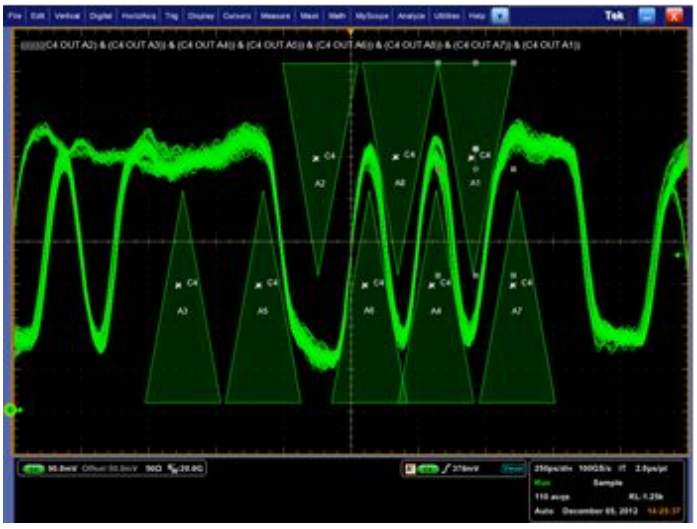
The DPO70000SX-series provides the highest trigger system performance available in a real time scope. The figure shows triggering on <50 ps bit-wide runt pulses (fails to cross both thresholds within specified time) on 25.78 GBaud (100GbE) signaling. High system bandwidth and extreme trigger timer precision enable reliable capture of signal aberrations and efficient isolation of fault conditions.

In the next figure, pulse width discrimination is used to isolate pulses >40 ps and <60 ps wide, showing reliable capture of 50 ps pulses within a 20 Gbps PRBS11 sequence.

DPO70000SX includes a unique Envelope trigger mode that enables direct triggering on the envelope of a modulated carrier. Edge, Width and Timeout trigger types can be applied to a detected envelope to provide stable trigger on modulated bursts or discriminate bursts of a specific width. Carrier frequency can range from 500 MHz to 20 GHz to address a broad range of applications. The figure illustrates triggering on burst of specific width.



Visual Trigger further extends the Pinpoint Triggering's capabilities, adding another level of trigger qualification to find important events in a wide variety of complex signals. Visual Trigger qualifies Pinpoint triggers by scanning through all waveform acquisitions and comparing them to on-screen areas (geometric shapes). Up to eight areas can be created using a mouse or touchscreen, and a variety of shapes (triangles, rectangles, hexagons, or trapezoids) can be used to specify the desired trigger behavior. Once shapes are created, they can be edited interactively to create ideal trigger conditions



Signal acquisition

ATI input

The DPO77002SX 70 GHz ATI input channel uses industry-standard 1.85 mm coaxial connection system specified to 67 GHz, with typical performance to 70 GHz. The instrument includes a calibration-grade 1.85 mm female-female adapter installed in the ATI input connector (male) to provide mechanical protection and gender selection. Instruments also include a static protection wrist strap, torque wrench and a set of backing wrenches to facilitate proper care and installation of signal path elements, ensuring optimal measurement performance. The 1.85 mm connection system is compatible with 2.4 mm (50 GHz) elements.

TekConnect® inputs

DPO70000SX models include the TekConnect signal interconnect system, offering unparalleled versatility with a wide array of accessory signal access and conditioning solutions. The TCA-292D TekConnect adapter provides 2.92 mm connection, 50 Ω coaxial environment to 33 GHz.

Probing and remote-head coaxial input

Often the biggest challenge in debugging a system is getting access to required signals. Tektronix offers a wide array of probing solutions, including the P7600 and P7500 TriMode® probing system with bandwidths that are well matched to the DPO70000SX Series. This extensive probe offering is compatible with the TekConnect input available on all DPO70000SX models.

The P7600 and P7500 TriMode® probes allow you to switch among differential, single-ended, and common-mode measurements without moving the probe from its connection points. The P7600 series combines low noise, 33 GHz bandwidth and the convenience of TriMode probing. Coaxial adapters enable the probe to act like a remote-head differential input channel for the oscilloscope which effectively doubles the number of differential signals a single oscilloscope can measure simultaneously.

The P7500 Series offers probes with performance from 4 GHz to 25 GHz and offers several low-cost solder tips with quick connection features that allow moving the probe to various solder points fast and easy.

High performance Auxiliary Trigger input

DPO70000SX includes an Auxiliary Trigger input (TekConnect) suitable for high performance Edge triggering without consuming an acquisition channel. Aux trigger bandwidth is >10 GHz on the DPO70000SX-series with <1.5 ps_{RMS} jitter.

Channel timing deskew

All DPO70000SX models include differential fast-edge outputs matched to <1.6 ps on the front panel that provide a convenient source for aligning channel timing in a coaxial environment. Instruments include accessories to accomplish channel-to-channel timing deskew using the built-in source. Additional accessories can be purchased separately to accomplish even finer time alignment or deskew in a probe-based environment

Bench or rack mount

DPO70000SX models are equally suited for bench and rack-mounted use and complimented with a number of elements to address specific environments.

UltraSync cables are available in 1 meter and 2 meter lengths to enable configuration flexibility. The default 1 meter cable is suitable for typical two- and four-unit configurations with uniformly stacked instruments. The longer cable enables combinations operating at 90° to one another or face-to-face around a DUT. Cable length can be mixed in a configuration to suit application need and time de-skewed as a system to provide precise channel-to-channel time alignment.

Instrument cases include recesses that align with feet such that stacked units mechanically engage one another for added stability. This feature also works in inverted-stacking configurations and mixed stacks that include an OM4000 Optical Receiver. Models include threaded holes for user-provided side brackets in cases where specific combinations are to be "locked" together.

Rack environment

The DPO70000SX rack mount is a tray directly attached to the instrument. The tray occupies 1U rack height in addition to the 3U instrument and preserves a cooling channel for the unit. The rack mount also provides heavy-duty carry handles for transporting the instrument outside the rack environment.

The rack-mounting kit allows units to be mounted upright or inverted to minimize input cable length, just as when stacking on a bench.

The DPO70000SX rack-mount tray can also house a front-mounted Solid State Drive (SSD) for easy access to instrument mass storage in a rack environment.

Specifications [2]

Model overview

	DPO77002SX/DPS77004SX		DPO75902SX/DPS75904SX		DPO75002SX/DPS75004SX	
	ATI channel	**TekConnect channels**	**ATI channel**	**TekConnect channels**	**ATI channel**	**TekConnect channels**
Analog channels/bandwidth	DPO77002SX 1 ch/67 GHz 1 ch/70 GHz (typical) DPS77004SX 2 ch/67 GHz 2 ch/70 GHz (typical)	DPO77002SX 2 ch/33 GHz DPS77004SX 4 ch/33 GHz	DPO75902SX 1 ch/59 GHz DPS75904SX 2 ch/59 GHz	DPO75902SX 2 ch/33 GHz DPS75904SX 4 ch/33 GHz	DPO75002SX 1 ch/50 GHz DPS75004SX 2 ch/50 GHz	DPO75002SX 2 ch/33 GHz DPS75004SX 4 ch/33 GHz
Sample rate per channel	200 GS/s	100 GS/s	200 GS/s	100 GS/s	200 GS/s	100 GS/s
Rise time (typical)	10% to 90%: 5.6 ps 20% to 80%: 4.3 ps	10% to 90%: 13 ps 20% to 80%: 9 ps	10% to 90%: 6.8 ps 20% to 80%: 5.2 ps	10% to 90%: 13 ps 20% to 80%: 9 ps	10% to 90%: 7.8 ps 20% to 80%: 6 ps	10% to 90%: 13 ps 20% to 80%: 9 ps
Vertical Noise (% of full scale), BWE on, max sample rate (typical)	0.83% of full scale	0.71% of full scale	0.83% of full scale	0.71% of full scale	0.83% of full scale	0.71% of full scale
	0.75% of full scale @ 0 V offset (300 mV_{FS})	0.56% of full scale @ 0 V offset (500 mV_{FS})	0.75% of full scale @ 0 V offset (300 mV_{FS})	0.56% of full scale @ 0 V offset (500 mV_{FS})	0.75% of full scale @ 0 V offset (300 mV_{FS})	0.56% of full scale @ 0 V offset (500 mV_{FS})
Record length, points (each channel, standard)	62.5 M	62.5 M	62.5 M	62.5 M	62.5 M	62.5 M
Record length (each channel, Opt. 10XL)	125 M	125 M	125 M	125 M	125 M	125 M
Record length (each channel, Opt. 20XL)	250 M	250 M	250 M	250 M	250 M	250 M
Record length (each channel, Opt. 50XL)	1 G	1 G	1 G	1 G	1 G	1 G
Timing resolution	5 ps (200 GS/s)	10 ps (100 GS/s)	5 ps (200 GS/s)	10 ps (100 GS/s)	5 ps (200 GS/s)	10 ps (100 GS/s)
Duration at highest sample rate (Standard)	313 µs	625 µs	313 µs	625 µs	313 µs	625 µs
Duration at highest sample rate (Opt. 10XL)	625 µs	1.25 ms	625 µs	1.25 ms	625 µs	1.25 ms
Duration at highest sample rate (Opt. 20XL)	1.25 ms	2.5 ms	1.25 ms	2.5 ms	1.25 ms	2.5 ms
Duration at highest sample rate (Opt. 50XL)	5.0 ms	10 ms	5.0 ms	10 ms	5.0 ms	10 ms

2 All specifications are guaranteed unless noted otherwise.

Model overview

	DPO73304SX/DPS73308SX	DPO72304SX
	TekConnect channels	**TekConnect channels**
Analog channels/bandwidth	DPO73304SX 2 ch/33GHz, 4 ch/23GHz DPS73304SX 4 ch/33GHz, 8 ch [3]/23GHz	DPO72304SX 4 ch/23GHz
Sample rate per channel	DPO73304SX 2 ch 100 GS/s, 4 ch 50 GS/s DPS73304SX 4 ch 100 GS/s, 8 ch [3] 50 GS/s	2 ch 100 GS/s, 4 ch 50 GS/s
Rise time (typical)	10% to 90%: 13 ps 20% to 80%: 9 ps	10% to 90%: 17 ps 20% to 80%: 13 ps
Vertical Noise (% of full scale), BWE on, max sample rate (typical)	0.71% of full scale	0.71% of full scale
	0.56% of full scale @ 0V offset (500 mV_{FS})	0.56% of full scale @ 0 V offset (500 mV_{FS})
Record length, points (each channel, standard)	62.5 M	62.5 M
Record length (each channel, Opt. 10XL)	125 M	125 M
Record length (each channel, Opt. 20XL)	250 M	250 M
Record length (each channel, Opt. 50XL)	DPO73304SX 1 G on 2 ch, 500 M on 4 ch DPS73304SX 1 G on 2 ch each unit, 500 M on 4 ch each unit	1 G on 2 ch, 500 M on 4 ch
Timing resolution	10 ps (100 GS/s)	10 ps (100 GS/s)
Duration at highest sample rate (Standard)	625 µs	625 µs
Duration at highest sample rate (Opt. 10XL)	1.25 ms	1.25 ms
Duration at highest sample rate (Opt. 20XL)	2.5 ms	2.5 ms
Duration at highest sample rate (Opt. 50XL)	10 ms	10 ms

Vertical system - analog channels

Input coupling

TekConnect channels: Two modes: DC, 50 ohms to a programmable termination voltage; Ground.

The termination can be connected to a DC voltage:

≤ 1.2 V_{FS} settings: -3.5 V to 3.5 V,

> 1.2 V_{FS} settings: 0.0 V

ATI channel: DC, 50 Ω.

Input resistance

≤1.2 V_{FS} settings 50 Ω ±3% at 18 to 28 ºC (64 to 82 ºF)

50 Ω ±4% over 5 to 45 ºC (45 to 113 ºF)

>1.2 V_{FS} settings 50 Ω ±4.4% over 5 to 45 ºC (45 to 113 ºF)

3 Maximum of 4 channels displayed on-screen. Additional channels data available through program interface.

Vertical system - analog channels

Sensitivity range

TekConnect channels	62.5 mV_{FS} to 6 V_{FS}
ATI channel	100 mV_{FS} to 300 mV_{FS}.

Maximum input voltage

TekConnect channels:	≤1.2 V_{FS} settings:
	±1.5 V relative to the termination bias (30 mA maximum)
	±5 V absolute maximum input
	>1.2 V_{FS} settings:
	±8 V. Limited by maximum Vterm current and the attenuator power rating at maximum temperature.
ATI channel:	±0.75 V_{pk}
Aux channel:	±5.0 V_{pk}

Input termination voltage (VTerm) range, TekConnect channels

≤1.2 V_{FS} settings:	-3.5 V to +3.5 V
>1.2 V_{FS} settings:	0 V

Frequency response tolerance

All modes, BWE on, 18 ºC to 28 ºC (typical)	
TekConnect channel:	Step settings TekConnect channels: 77.5 mV_{FS}, 151 mV_{FS}, 302 mV_{FS}, 605 mV_{FS}, 1210 mV_{FS}., 1620 $mV_{FS,}$ 3240 mV_{FS}
	±0.5 dB from DC to 50% of nominal BW
	±1.5 dB from 50% to 80% of nominal BW
	All other gain settings:
	±1.0 dB from DC to 50% of nominal BW
	±2.0 dB from 50% to 80% of nominal BW
ATI channel:	All volts/div settings
	±0.5 dB from DC to 20 GHz
	±0.75 dB from >20 GHz to 30 GHz
	±1.25 dB from >30 GHz to 68.5 GHz
	±2 dB from >68.5 GHz to 69.5 GHz
	+2 / -3 dB at 70 GHz

Bandwidth limit	Depending on instrument model: 70 GHz to 1 GHz in 1 GHz steps, or 500 MHz; 5 GHz steps above 35 GHz
	Hardware-only bandwidth settings at 33 GHz available on non-ATI channels. No hardware-only settings available on ATI channel.
Vertical resolution	8 bits, (11 bits with averaging)
DC gain accuracy	± 2%

Vertical system - analog channels

Effective number of bits (typical). Average value from DC to full bandwidth of model.

70 GHz ATI Channel	4.6 bits at 250 mV FS, 200GS/s
59 GHz ATI Channel	4.8 bits at 250 mV FS, 200GS/s
50 GHz ATI Channel	5.0 bits at 250 mV FS, 200GS/s
33 GHz TekConnect Channels	5.0 bits at 500 mV FS, 100GS/s
23 GHz TekConnect Channels	5.4 bits at 500 mV FS, 100GS/s

Offset range

TekConnect channels

Full Scale voltage range	Offset range
62.5 mV_{FS} – 1.2 V_{FS}	±3.4 V
>1.2 V_{FS} – 6 V_{FS}	±6 V

ATI channel

Full Scale voltage range	Offset range
100 mV_{FS} – 300 mV_{FS}	±300 mV - (10 div × Volts/div)

Offset accuracy

Full scale voltage range	Offset accuracy
100 mV_{FS} to 300 mV_{FS} (ATI channel) 62.5 mV_{FS} to 1.2 V_{FS} (TekConnect channels)	±(0.4% | net offset | + 0.2% | net offset – Vterm setting | + 2.5 mV + 1% FS)
>1.2 V_{FS} to 6 V_{FS} (TekConnect channels)	±(0.6% | net offset | + 13.4 mV + 1% FS)

Position range ± 5 divisions

Vertical system - analog channels

Channel-to-channel crosstalk (channel isolation), typical

Input frequency range (up to the rated bandwidth). Assumes two channels with the same scale and bandwidth settings. The limits apply up to the bandwidth of the particular instrument.

ATI models		
Specified channels	**Instrument frequency range**	**Isolation**
ATI channels (isolation between any two [or more] ATI channels in separate units), requires UltraSync	DC to 70 GHz	70 dB
TekConnect channels in an ATI unit (isolation between channels 1 and 3)	DC to 33 GHz	60 dB
TekConnect channels to ATI channel (isolation between channels 1 and 3 to channel 2)	DC to 4 GHz	55 dB
	>4 GHz to 10 GHz	45 dB
	>10 GHz to 20 GHz	35 dB
	>20 GHz to 30 GHz	30 dB
	>30 GHz to 33 GHz	27 dB
ATI channel to TekConnect (non-ATI) channels (isolation between channel 2 and channels 1 or 3)	DC to 3 GHz	55 dB
	>3 GHz to 12 GHz	40 dB
	>12 GHz to 33 GHz	30 dB
	>33 to 70 GHz	60 dB

TekConnect models (non-ATI)		
Specified channels	**Instrument frequency range**	**Isolation**
Isolation between channels 1 or 2 and channels 3 or 4	DC to 33 GHz	60 dB
Isolation between channels 1 and 2, or channels 3 and 4	DC to 2 GHz	60 dB
	>2 to 10 GHz	42 dB
	>10 to 20 GHz	35 dB
	>20 to 33 GHz	30 dB

Horizontal system

Time base accuracy

±0.8 x 10^{-6} ±0.3 x 10^{-6} aging/year after first year when operated within 23°C ±5°C after 30 minute warm-up.

Typical: ±0.1 x 10^{-6} initial accuracy after adjustment.

Time base delay time range

–5.0 ks to 1.0 ks

Sample Clock Jitter (typical)

<5 µs Duration: 65 fs_{RMS}

Trigger jitter (typical)

10 fs using enhanced trigger placement.

Horizontal system

Time/Div settings

ATI channel (only sample rate is 200 GS/s)	Max RT setting: 500 µs/div (with 1G RL, 50XL option) Min RT setting: 25 ps/div Max IT setting: 250 µs/div (with 1G RL, 50XL option) Min IT setting: 500 fs/div
TekConnect channels [4] (at max sample rate of 100 GS/s)	Max RT setting: 1 ms/div (with 1G RL, 50XL option) Min RT setting: 50 ps/div Max IT setting: 10 µs/div (with 1G RL, 50XL option) Min IT setting: 500 fs/div
Delay between channels, BWE (typical)	≤ 500 fs between any two channels within the same box at any gain setting at 25 °C ±5 °C prior to any user adjustment. Manual adjustment available with 10 fs minimum resolution. Derate linearly to ≤ 3 ps at 5 °C and 45 °C.
Channel skew stability, UltraSync (typical)	≤ 250 fs_{RMS} between any two channels between instruments at any gain setting at 25 °C ±5 °C. Derate linearly to ≤ 3 ps at 5 °C and 45 °C.
Channel-to-Channel deskew range	±75 ns

Acquisition system

Acquisition modes

Sample	Acquires and displays sampled values
Average	From 2 to 10,000 waveforms can be included in an average waveform
Envelope	From 1 to 2×10^9 waveforms included in min-max envelope
Hi-Res	Real-time boxcar averaging reduces random noise and increases resolution
Peak detect	Capture and display narrow glitches at all real-time sampling rates. Glitch widths: 1 ns at ≤125 MS/s; 1/sample rate at ≥250 MS/s
FastAcq® (TekConnect channels only)	FastAcq® optimizes the instrument for analysis of dynamic signals and capture of infrequent events, capturing >300,000 waveforms per second on all TekConnect channels simultaneously, standalone configuration only
FastFrame™	Acquisition memory divided into segments; maximum trigger rate >310,000 waveforms per second. Time of arrival recorded with each event. Frame finder tool helps to visually identify transients. TekConnect channels only, standalone configuration only
Roll mode	Scrolls sequential waveform points across the display in a right-to-left rolling motion. Works at sample rates up to 10 MS/s with a maximum record length of 40 MS. TekConnect channels only, standalone configuration only
Waveform database	Accumulates waveform data providing a three-dimensional array of amplitude, time, and counts. TekConnect channels only, standalone configuration only

Pinpoint® Trigger system

Trigger sensitivity (typical)

Internal DC coupled	A-Event trigger, B-Event trigger	≤ 5%FS from DC to 50 MHz ≤ 7.5%FS at 5 GHz ≤ 10%FS at 10 GHz ≤ 15%FS at 15 GHz ≤ 35%FS at 20 GHz ≤ 50%FS at 25 GHz
Aux input 50 Ω (external trigger)	Auxiliary input	100 mV_{pp} from DC to 1 GHz 175 mV_{pp} at 4 GHz 225 mV_{pp} at 8 GHz 325 mV_{pp} at 10 GHz 800 mV_{pp} at 12 GHz

4 Sample rate on TekConnect channels can be varied down to 3.125 samples/second, resulting in a max RT setting of 6.55 Ms/div, with a record length of 205 M (requires 250 M or higher RL, 20XL option)

Pinpoint® Trigger system

Edge trigger sensitivity, non-DC-coupled modes (typical)

All sources, positive or negative edge, for vertical scale settings ≥10 mV/div and ≤1 V/div

Trigger Coupling	Sensitivity
NOISE REJ	15%FS from DC to 50 MHz 22.5% at 5 GHz 30%FS at 10 GHz 45%FS at 15 GHz 100%FS at 20 GHz
AC	Same as DC-coupled limits for frequencies > 100 Hz, attenuates signals <100 Hz
HF REJ	Same as DC-coupled limits for frequencies < 20 kHz, attenuates signals > 20 kHz
LF REJ	Same as DC-coupled limits for frequencies > 200 kHz, attenuates signals < 200 kHz
RF	Minimum hysteresis / High sensitivity
	A TRIG TekConnect 2.5% FS from DC to 50 MHz 2.5% FS at 5 GHz 2.5% FS at 10 GHz 5% FS at 15 GHz 7.5% FS at 20 GHz 12.5% FS at 25 GHz
	B TRIG TekConnect 2.5% FS from DC to 50 MHz 2.5% FS at 5 GHz 2.5% FS at 10 GHz 5% FS at 15 GHz 7.5% FS at 20 GHz 20% FS at 25 GHz
	A TRIG ATI 2.5% FS from DC to 50 MHz 2.5% FS at 5 GHz 2.5% FS at 10 GHz 5% FS at 15 GHz 10% FS at 20 GHz 23.5% FS at 25 GHz
	B TRIG ATI 2.5% FS from DC to 50 MHz 2.5% FS at 5 GHz 2.5% FS at 10 GHz 5% FS at 15 GHz 10% FS at 20 GHz 22.5% FS at 25 GHz

Pinpoint® Trigger system

A-Event and delayed B-Event trigger types

Standalone instrument	DPO73304SX DPO72304SX	DPO77002SX DPO75902SX DPO75002SX	
Trigger type	**TekConnect channel**	**ATI channel**	**TekConnect channel**
Edge	X	X	X
Glitch	X	X	X
Width	X	X	X
Runt	X	X	X
Window	X	X	X
Timeout	X	X	X
Period/Frequency	X	X	X
Envelope	X	X	X
Transition	X	X	X
Logic Pattern	X		X
Setup/Hold	X		X
Low speed serial	X	X	X
Logic state	X		

Multi-unit configuration	DPO73304SX DPO72304SX	DPO77002SX DPO75902SX DPO75002SX	
Trigger type	**TekConnect channel**	**ATI channel**	**TekConnect channel**
Edge	X	X	X
Glitch	X	X	X
Width	X	X	X

Main trigger modes

Auto, Normal, and Single

Trigger sequences

Main, Delayed by Time, Delayed by Events, Reset by Time, Reset by State, Reset by Transition. All sequences can include a separate horizontal delay after the trigger event to position the acquisition window in time

Trigger coupling

DC, AC (attenuates <100 Hz)

HF Rej (attenuates >20 kHz)

LF Rej (attenuates <200 kHz)

Noise Reject (reduces sensitivity)

RF coupling (increases trigger sensitivity and bandwidth at the highest operating frequencies)

Variable A-Event trigger holdoff range

250 ns to 12 s + random holdoff

Trigger level or threshold range

Trigger Source	Range
Ch1, 2, 3, or 4	Full scale
Auxiliary input	±3.65 V
Line	0 V, Not settable

Pinpoint® Trigger system

Enhanced triggering

Enhanced triggering corrects the difference in timing between the trigger path and the acquired data path (supports all Pinpoint trigger types on both A- and B-Events except pattern trigger); Default On (user-selectable); Not available in FastAcq mode.

Line trigger

Trigger on power line signal. Level fixed at 0 V.

Visual Trigger

Requires Option VET

- **Max number of areas**: 8
- **Area shapes**: Rectangle, Triangle, Trapezoid, Hexagon, user defined shapes (can have >40 vertices)
- **Compatibility**: Visual Trigger qualification is compatible with all trigger types and all trigger sequences

Trigger types

Trigger type	Description
Edge	Positive or negative slope on any channel or front-panel auxiliary input. Coupling includes DC, AC, noise reject, HF reject, LF reject, and RF coupling.
Frequency/Period	Trigger on event that crosses threshold twice with same slope within or outside of selectable time limits. Slope may be positive, negative or either.
Glitch	Trigger on or reject glitches of positive, negative, or either polarity. Minimum glitch width is 40 ps (typical) with rearm time of 50 ps (<5 ns interval), 75 ps above 5 ns.
Pattern	Trigger when pattern goes false or stays true for specified period of time. Pattern (AND, OR, NAND, NOR) specified for four input channels.
Runt	Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again. Event can be time- or logic-qualified. Minimum runt width is 40 ps (typical) with rearm time of 50 ps
Setup/Hold	Trigger on violations of both setup time and hold time between clock and data present on any two input channels.
State	Any logical pattern of channels (1, 2, 3) clocked by edge on channel 4. Trigger on rising or falling clock edge.
Timeout	Trigger on an event which remains high, low, or either, for a specified time period. Selectable from 300 ps.
Transition	Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either.
Width	Trigger on width of positive or negative pulse either within or out of selectable time limits (down to 40 ps).
Window	Trigger on an event that enters or exits a window defined by two user-adjustable thresholds. Event can be time or logic qualified.
Visual Trigger	Trigger when the Visual Trigger expression is satisfied.
Envelope	Qualification applied to Edge, Glitch, Width or Runt trigger such that trigger type is performed on the detected envelope of a modulated carrier. Carrier frequency 250 MHz to 15 GHz. Minimum burst width <20 ns, maximum gap between bursts <20 ns.

Trigger modes

Trigger modes

Trigger mode	Description
Trigger Delay by Events	1 to 2 billion events.
Trigger Delay by Time	3.2 ns to 3 million seconds.
B-Event Scan	B-Event Scan is an A to B trigger sequence that will trigger and capture burst event data of interest as defined in the B-Event Scan setup menu. Captured bits can be scanned in a sequential or randomized fashion, and alternatively the trigger can toggle between two successive B trigger events. Eye diagrams can be constructed with burst data acquired as a result of scanning B-Event.

Waveform analysis

Search and Mark Events

Search and Mark Events	Search for edges, glitches, or pulses of specified width. Any events found matching the search criteria are marked and placed in the Event table. The search can use positive/negative slopes or both on any channels. When an event of interest is found, other similar events can be found using "Mark All Trigger Events in Record" in the Pinpoint trigger control windows. The Event table summarizes all found events. All events are time stamped in reference to trigger position. Users can choose to stop acquisitions when an event is found.

Waveform measurements

Waveform measurements	
Automatic measurements	54, of which 8 can be displayed on-screen at any one time; measurement statistics, user-definable reference levels, measurement within gates isolating the specific occurrence within an acquisition to measure The DPOJET Jitter and Eye Analysis application offers additional automated and advanced measurements such as jitter.
Amplitude related	Amplitude, High, Low, Maximum, Minimum, Peak-to-Peak, Mean, Cycle Mean, RMS, Cycle RMS, Positive Overshoot, Negative Overshoot
Time related	Rise Time, Fall Time, Positive Width, Negative Width, Positive Duty Cycle, Negative Duty Cycle, Period, Frequency, Delay
Combination	Area, Cycle Area, Phase, Burst Width
Histogram related	Waveform Count, Hits in Box, Peak Hits, Median, Maximum, Minimum, Peak-to-Peak, Mean (μ), Standard Deviation (sigma), μ +1sigma, μ +2sigma, μ +3sigma
Waveform processing/math	
Algebraic expressions	Define extensive algebraic expressions including Waveforms, Scalars, User-adjustable Variables, and Results of Parametric Measurements e.g. (Integral (CH1 – Mean(CH1)) × 1.414 × VAR1)
Arithmetic	Add, Subtract, Multiply, Divide Waveforms and Scalars
Filtering function	User-definable filters. Users specify a file containing the coefficients of the filter. Several example filter files are provided
Frequency domain functions	Spectral Magnitude and Phase, Real and Imaginary Spectra
Mask function	Generates a Waveform Database pixel map from a sample waveform. Sample count can be defined
Math functions	Average, Invert, Integrate, Differentiate, Square Root, Exponential, Log 10, Log e, Abs, Ceiling, Floor, Min, Max, Sin, Cos, Tan, ASin, ACos, ATan, Sinh, Cosh, Tanh
Relational	Boolean result of comparison >, <, ≥, ≤, ==, !=
Vertical units	Magnitude: Linear, dB, dBm Phase: Degrees, radians, group delay IRE and mV units
Window functions	Rectangular, Hamming, Hanning, Kaiser-Bessel, Blackman-Harris, Gaussian, Flattop2, Tek Exponential
Customized Functions using Math Plug-in Interface	An interface is provided to allow users to create their own custom math functions in MATLAB or Visual Studio

Display system

Color palettes	Normal, Green, Gray, Temperature, Spectral, and User-defined
Format	YT, XY, XYZ
Display resolution	1024 horizontal × 768 vertical pixels (XGA)
Display type	6.5 in. liquid-crystal active-matrix color display with capacitive touch screen
Horizontal divisions	10
Vertical divisions	10
Waveform styles	Vectors, Dots, Variable Persistance, Infinite Persistance

Computer system and peripherals

Operating system	Microsoft Windows 7 Ultimate - 64 bit OS
CPU	INTEL CORE I7-4970S, 3.9 GHz, QUAD CORE
System memory	32 GB
Solid state drive	Removable, ≥900 GB capacity
Mouse	Optical wheel mouse, USB interface
Keyboard	USB interface

Input-output ports

Auxiliary trigger input characteristics and range	50 Ω, ±5 V (DC plus peak AC)
Auxiliary output logic polarity and functionality	Default output is A trigger low true (a negative edge when the A trigger event occurs). You can also program the output to A trigger high true, B trigger low or high true, disabled, force high, and force low.
Fast Edge output step amplitude and offset	1200 mV differential into a 100 Ω load with a -300 mV common mode.
External reference input frequency (typical)	10 MHz, 100 MHz, 12.5 GHz The instrument scans for either 10 MHz or 100 MHz. 12.5 GHz supported on separate SMA input.
12.5 GHz Clock In	1.3 V_{p-p} (6 dBm)
B, C, D 12.5 GHz Clock Out (UltraSync)	1.3 V_{p-p} (6 dBm)
Internal reference output voltage (typical)	
10 MHz Vout pk-pk	> 800 mV peak-peak into 50 Ω > 1.6 V peak-peak into 1 MΩ (internally AC coupled).
Input and output ports	
DVI-D Video port	A female Digital Visual Interface (DVI-D) compatible port
VGA port	A female Video Graphics Array (VGA) compatible port
DisplayPort	Two connectors (primary, secondary) provide digital display interfaces
PCIe	PCIe ports to configure multi-instrument systems
Trigger	UltraSync trigger bus
Keyboard and Mouse ports	PS-2 compatible, instrument must be powered down to make connection
LAN ports	Two RJ-45 connectors (LAN1, LAN2), support 10BASE-T, 100BASE-TX, and Gigabit Ethernet
External audio ports	External audio jacks for microphone input and line output
USB ports	Four front panel USB 2.0 connectors Four rear panel USB 3.0/USB 2.0 connectors One rear panel USB device connector

Data storage specifications

Nonvolatile memory retention time (typical)	>20 years
Solid state drive	Waveforms and setups are stored on the solid state drive. Solid state drive is a ≥900 GB solid state drive (removable).

Power source

Power consumption	<980 W, single instrument, maximum ≤780 W, single unit (typical)
Source voltage and frequency	100 V to 240 V_{RMS}, 50/60 Hz 115 V ±10%, 400 Hz CAT II

Mechanical specifications

Dimensions

DPO70000SX models	157 mm (6.0 in) height 452 mm (17.8 in) width 553 mm (21.8 in) depth
DPO70000SX models, Rackmount configuration	177 mm (7.0 in) height 440 mm (19.75 in) width 523 mm (20.6 in) depth (from rack mounting ear to back of instrument)

Weight

DPO70000SX models	19 kg (42 lbs) oscilloscope only

Cooling

Required clearances

Fan-forced air circulation with no air filter	
Top	0 mm (0 in)
Bottom	6.35 mm (0.25 in) minimum or 0 mm (0 in) when standing on feet, flip stands down
Left side	76 mm (3 in)
Right side	76 mm (3 in)
Rear	0 mm (0 in) on rear feet

Environmental specifications

Temperature

Operating	+5 °C to +45 °C
Nonoperating	-20 °C to +60 °C

Environmental specifications

Humidity

Operating	8% to 80% relative humidity at up to +32 °C (+90 °F)
	5% to 45% relative humidity above +32 °C (+90 °F) up to +45 °C (+113 °F), noncondensing, and is limited by a maximum wet-bulb temperature of +29.4 °C (+85 °F) (derates relative humidity to 32% at +45 °C (+113 °F)
Nonoperating	5% to 95% relative humidity at up to +30 °C (+86 °F),
	5% to 45% relative humidity above +30 °C (+86 °F), up to +60 °C (+140 °F), noncondensing, and is limited by a maximum wet-bulb temperature of +29.4 °C (+85 °F) (derates relative humidity to 11% at +60 °C (+140 °F))

Altitude

Operating	Up to 3,000 meters
Nonoperating	Up to 12,000 meters

United States Government Baseline Testing

United States Government Configuration Baseline (USGCB) Testing	Tektronix has tested the DPO70000SX Series oscilloscopes for compatibility with the security configuration for Information Technology products specified in the USGCB settings for Windows 7 and Internet Explorer

Regulatory

Regulatory

Electromagnetic compatibility	2004/108/EC; EN 61326-2-1
Certifications	UL 61010-1, CSA 61010-1-04, LVD 2006/95/EC, EN61010-1, IEC 61010-1

Ordering information

Models

DPO77002SX	70 GHz ATI Performance Oscilloscope
DPO75902SX	59 GHz ATI Performance Oscilloscope
DPO75002SX	50 GHz ATI Performance Oscilloscope
DPO73304SX	33 GHz Digital Phosphor Oscilloscope
DPO72304SX	23 GHz Digital Phosphor Oscilloscope

Systems

The following DPS systems provide single-nomenclature ordering convenience for 2 instruments and a 1 meter UltraSync cable. The same options may be applied to these systems as with base models and the option will be included on both instruments. Both component instruments will have the same options associated with the system nomenclature when operating standalone.

DPS77004SX	70 GHz ATI Performance Oscilloscope System: 2 x 70 GHz, 200 GS/s or 4 x 33 GHz, 100 GS/s
DPS75904SX	59 GHz ATI Performance Oscilloscope System: 2 x 59 GHz, 200 GS/s or 4 x 33 GHz, 100 GS/s
DPS75004SX	50 GHz ATI Performance Oscilloscope System: 2 x 50 GHz, 200 GS/s or 4 x 33 GHz, 100 GS/s
DPS73308SX	33 GHz Digital Phosphor Oscilloscope System: 4 x 33 GHz, 100 GS/s or 8 x 23 GHz , 50 GS/s

Standard accessories

ATI channel accessories

Accessory	Tektronix part number
Deskew adapter (1.85M to 2.92F)	103-0488-00
ATI connector saver (1.85 mm)	103-0474-00
ATI protective cap	016-2101-00
Torque wrench	067-2787-00
Backing wrench	003-1942-00

Instrument accessories

Accessory	Tektronix part number
User manual -- depends on language option	071-3357-xx
Front protective cover	200-5337-00
PCIe Host Port protective plug	200-5344-00
2nd ethernet port plug	200-5389-00
50 Ω term on Fast Edge (2X)	015-1022-01
TCA-292D (5X) (3X on ATI instruments)	090-0044-00
Windows compatible keyboard	119-7275-xx
Windows compatible mouse	119-7054-xx
Static protection wrist strap	006-3415-05
Deskew cable (M2.92 to M2.92)	174-6793-00
Accessories pouch	016-2045-00

Accessory	Tektronix part number
Best Practices manual	071-2989-04
ROHS info	071-2185-04
Calibration certification	001-1179-00
Cal cert envelope	006-8018-01
Power cord	

Warranty

One-year warranty covering all parts and labor.

Instrument options

Record length options

Opt. 10XL	125 MS/Ch
Opt. 20XL	250 MS/Ch
Opt. 50XL	500 MS/Ch on 4 channels, 1 G/Ch on 2 channels

Trigger and limit test options

Option	Description
Opt. VET	Visual trigger
Opt. ASM	Advanced Event Search and Mark
Opt. LT	Waveform limit testing

Advanced analysis options

Option	Description
Opt DJA	Jitter and Eye Analysis Tools - Advanced (DPOJET)
Opt DJAN	DPOJET Noise, Jitter and Eye Analysis Tools (requires DJA)
Opt SDLA64	Serial Data Link Analysis Visualizer
Opt. VET	Visual Trigger
Opt. LT	Waveform Limit Testing
Opt. PAM4	PAM4 Transmitter Analysis Software

Spectral and modulation analysis

Option	Description
Opt. SVE	SignalVu® Essentials - Vector Signal Anallysis Software
Opt. SVA	AM/FM/PM Audio Signal Analysis (Requires Opt. SVE)
Opt. SVM	General Putpose Modulation Analysis (Requires Opt. SVE
Opt. SVO	Flexible OFDM Analysis (Requires Opt. SVE)
Opt. SVP	Advanced Signal Analysis (including pulse measurements) (Requires Opt. SVE)
Opt. SVT	Frequency and Phase Settling Time Measurements (Requires Opt. SVE)
Opt. SV23	WLAN802.11a/b/g/j/p measurement application (requires Opt. SVE)
Opt. SV24	WLAN 802.11n measurement application (requires Opt SV23)
Opt. SV25	WLAN 802.11ac measurement application (requires Opt SV24)

Option	Description
Opt. SV27	SignalVu Bluetooth Basic LE TX SIG measurements
Opt. SV28	SignalVu LTE Downlink RF measurements (requires Opt. SVE)

Storage options

Option	Description
Opt. SSD	Additional Removable Disk - Solid State Drive

Floating license options

Floating licenses offer an alternative method to manage your Tektronix asset. Floating licenses allow license-key enabled options to be easily moved among all your MSO/DPO70000, DPO7000, and MSO/DPO5000 Series oscilloscopes. Floating licenses are available for the license-key enabled options listed below.

Check www.tektronix.com/products/oscilloscopes/floating-licenses for additional information about floating license options.

Option	Description
DPOFL-XL010	Extended record length - 125 M Samples/Ch
DPOFL-XL020	Extended record length - 250 M Samples/Ch
DPOFL-XL050	Extended record length - 500 M Samples/Ch
DPOFL-DJA	Jitter and Eye Analysis Tools - Advanced (DPOJET)
DPOFL-DJAN	DPOJET Noise, Jitter and Eye Analysis Tools
DPOFL-SDLA64	Serial Data Link Analysis Visualizer
DPOFL-VET	Visual Trigger
DPOFL-LT	Waveform Limit Testing
DPOFL-SVE	SignalVu® Essentials - Vector Signal Analysis Software
DPOFL-SVA	AM/FM/PM Audio Signal Analysis (Requires Opt. SVE)
DPOFL-SVM	General Purpose Modulation Analysis (Requires Opt. SVE)
DPOFL-SVO	Flexible OFDM Analysis (Requires Opt. SVE)
DPOFL-SVP	Advanced Signal Analysis (including pulse measurements) (Requires Opt. SVE)
DPOFL-SVT	Frequency and Phase Settling Time Measurements (Requires Opt. SVE)
DPOFL-SV23	WLAN 802.11a/b/g/j/p measurement application (requires Opt. SVE)
DPOFL-SV24	WLAN 802.11n measurement application (requires Opt. SV23)
DPOFL-SV25	WLAN 802.11ac measurement application (requires Opt. SV24)
DPOFL-SV27	SignalVu Bluetooth Basic LE TX SIG measurements
DPOFL-SV28	SignalVu LTE Downlink RF measurements (requires Opt. SVE)

Upgrade options

The DPO70000SX Series instruments can be easily upgraded after initial time of purchase. To upgrade an existing DPO70000SX, order DPO-UP and an option listed below. For example, DPO-UP DJAN.

Memory upgrades for DPO70000SX Series

XL510	Standard Configuration to Option 10XL Configuration
XL520	Standard Configuration to Option 20XL Configuration
XL550	Standard Configuration to Option 50XL Configuration
XL1020	Option 10XL Configuration to Option 20XL Configuration
XL1050	Option 10XL Configuration to Option 50XL Configuration
XL2050	Option 20XL Configuration to Option 50XL Configuration

Trigger and search upgrades for DPO70000SX Series

VETU	Visual Trigger
LT	Waveform Limit Testing

Advanced analysis upgrades for DPO70000SX Series

DJA	Jitter and Eye Analysis Tools - Advanced (DPOJET)
DJAN	DPOJET Noise, Jitter and Eye Analysis Tools (Requires DJA)
SDLA64	Serial Data Link Analysis Visualizer

Spectral and modulation analysis upgrades for DPO70000SX Series

Option	Description
SVEU	SignalVu® Essentials - Vector Signal Anallysis Software
SVA	AM/FM/PM Audio Signal Analysis (Requires Opt. SVE, SVEH, or SVEU)
SVM	General Putpose Modulation Analysis (Requires Opt. SVE, SVEH, or SVEU)
SVO	Flexible OFDM Analysis (Requires Opt. SVE, SVEH, or SVEU)
SVP	Advanced Pulsed Signal Analysis including Measurements (Requires Opt. SVE, SVEH, or SVEU)
SVT	Freqauency and Phase Settling Time Measurements (Requires Opt. SVE, SVEH, or SVEU)
SV23	WLAN802.11a/b/g/j/p measurement application (Requires Opt. SVE, SVEH, or SVEU)
SV24	WLAN 802.11n measurement application (requires Opt SV23)
SV25	WLAN 802.11ac measurement application (requires Opt SV24)
SV27	SignalVu Bluetooth Basic LE TX SIG measurements
SV28	SignalVu LTE Downlink RF measurements (requires Opt. SVE)

Other upgrades for DPO70000SX Series

IF	Upgrade Installation Service
SSD	Spare Solid State Drive

Investment protection options

As signals get faster and new standards are developed, your investment in an DPO70000SX Series instrument can evolve with your needs. You can upgrade the bandwidth of the unit you own today. You can take advantage of DPO70000SX series performance improvements by upgrading your existing unit to a new series. Contact your local Tektronix representative to discuss the full range of options available to ensure your DPO70000SX series oscilloscope has the tools you need for your next project.

Power plug options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 50/60 Hz)
Opt. A10	China power plug (50 Hz)
Opt. A11	India power plug (50 Hz)

Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. G3	Complete Care 3 Years (includes loaner, scheduled calibration, and more)
Opt. G5	Complete Care 5 Years (includes loaner, scheduled calibration, and more)
Opt. IF	Upgrade Installation Service
Opt. R3	Repair Service 3 Years (including warranty)
Opt. R5	Repair Service 5 Years (including warranty)

Recommended accessories

Probes

P7633	33 GHz Low Noise TriMode® Probe
P7630	30 GHz Low Noise TriMode® Probe
P7625	25 GHz Low Noise TriMode® Probe
P7520A	25 GHz TriMode® probe
P7313SMA	13 GHz TriMode® differential SMA probe
P6251	DC to 1 GHz, 42 V, differential probe (requires TCA-BNC adapter)
TCPA300/TCPA400 Series	Current measurement systems
P5200/P5205/P5210	High-voltage differential probes
067-2431-xx	Probe Deskew Fixture for SMA or solder-down connections (up to 30 GHz)
067-0484-xx	Analog Probe Calibration and Deskew Fixture (4 GHz)
067-1586-xx	Analog Probe Deskew Fixture (>4 GHz)
067-1686-xx	Power Deskew Fixture

Adapters

TCA-1MEG	TekConnect® high-impedance buffer amplifier. Includes P6139A passive probe
TCA-292D	TekConnect® to 2.92 mm adapter (33 GHz bandwidth)
TCA-BNC	TekConnect® to BNC adapter
TCA-N	TekConnect® to N adapter
TCA-VPI50	50 Ω TekVPI to TekConnect adapter
TCA75	8 GHz precision TekConnect® 75 Ω to 50 Ω adapter with 75 Ω BNC input connector

Other

016-2095-xx	Rackmount Kit
016-2102-xx	SSD mounting kit (front of instrument rackmount tray)
077-0076-xx	Service Manual, pdf on hard drive
016-2104-00	Transit Case (carbon fiber)
K4000	Oscilloscope Cart
DPO7AFP	Auxiliary Front Panel
DPO7USYNC 1M	1 meter UltraSync cable
DPO7USYNC 2M	2 meter UltraSync cable

Tektronix DPO 72004C Digital Phosphor Oscilloscope
Tektronix DPO 7354C Digital Phosphor Oscilloscope
Tektronix DPO70802SX ATI Performance Oscilloscope

The DPO70000SX Series offers the highest performance in Tektronix' Real Time performance oscilloscope portfolio.

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Product Area Assessed: The planning, design/development and manufacture of electronic Test and Measurement instruments.

ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
Japan 81 (3) 6714 3010
Middle East, Asia, and North Africa +41 52 675 3777
People's Republic of China 400 820 5835
Republic of Korea +822 6917 5084, 822 6917 5080
Spain 00800 2255 4835*
Taiwan 886 (2) 2656 6688

Austria 00800 2255 4835*
Brazil +55 (11) 3759 7627
Central Europe & Greece +41 52 675 3777
France 00800 2255 4835*
India 000 800 650 1835
Luxembourg +41 52 675 3777
The Netherlands 00800 2255 4835*
Poland +41 52 675 3777
Russia & CIS +7 (495) 6647564
Sweden 00800 2255 4835*
United Kingdom & Ireland 00800 2255 4835*

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Canada 1 800 833 9200
Denmark +45 80 88 1401
Germany 00800 2255 4835*
Italy 00800 2255 4835*
Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
Norway 800 16098
Portugal 80 08 12370
South Africa +41 52 675 3777
Switzerland 00800 2255 4835*
USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com.

Copyright © Tektronix, Inc. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks, or registered trademarks of their respective companies.

29 Sep 2015 55W-30662-6

www.tektronix.com

Tektronix®